In re Patent Application of:
FARRIES
Serial No. **09/886,998**
Filed: **06/25/2001**

REMARKS

Claims 1-17 are pending in this application.

Claims 1-12 and 15-17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ooi, et al. (US Patent 6,118,564) in view of Lin et al. (US Patent 6,782,203).

Claims 13-14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ooi, et al. (US Patent 6,118,564) in view of Pan et al. (US Patent 5,652,814).

Introduction

An object of instant invention is to provide a low loss, low error rate, high bit-rate demultiplexer capable of demultiplexing optical signals, particularly in the presence of overlap of adjacent wavelength channels.

In a wavelength division multiplex (WDM) optical communication system, a problem of optical crosstalk between adjacent channels can arise where the optical bandwidth of such channels widens as the transmission rate is increased while the spacing between channels is fixed, for instance according to the ITU frequency grid.

To practically solve the problem underlying the demultiplexing of closely placed wavelength channels in WDM systems, optical filters of high figure-of-merit and separating qualities are required. For a system of many channels this increases the cost, vulnerability to drift and can reduce reliability of transmission.

A further limitation of optical filters is that the achievable figure-of-merit tends to decrease as the width of the filter pass band is increased. Thus it is advantageous to reduce the optical signal bandwidth before performing the final filtering of a channel, often referred to as post-filtering.

With this invention, only a small number of high quality filters are required at the input of the demultiplexer where the WDM optical traffic gets split into several groups of closely spaced optical channels. Optical time domain multiplex (OTDM) is then used to reduce the bandwidth of each channel while maintaining the incipient channel spacing. Finally, to separate or demultiplex these narrow bandwidth signals, optical filters of lower figure-of-merit can be applied with no penalty.

This use of OTDM for reduction of channel bandwidth is novel, in particular when applied in three stages: WDM - OTDM - WDM. Known prior art systems consist of only the WDM - OTDM stages or WDM - electronic TDM stages.

Claims 1 and 15

Claim 1 has been amended to more clearly define the invention and distinguish it from prior art.

Paragraph lettering (a), (b), (c) has been introduced to expedite referencing for comparison of the instant application with prior art.

In this application it is particularly important to distinguish two different optical demultiplexing means:

wavelength demultiplexing and time domain demultiplexing, hence the addition of the word "wavelength" in 1 (c).

Furthermore, the subordinate clause has been added to 1(a) to emphasize that more than one wavelength channel is demultiplexed in the time domain demultiplexer. This is an important distinguishing feature from prior art.

It should be stressed that these changes in wording do not alter the substance of the claim, but merely clarify it in order to distinguish it more clearly from cited prior art.

The Examiner correctly states that
"*Ooi et al.* teach an optical demultiplexer for demultiplexing an optical signal having a plurality of channels at a predetermined channel spacing comprising: demultiplexing means (107A, Fig.7), time domain demultiplexing means (For example, 30-1, Fig.7) for receiving one of the plurality of wavelength streams and for dividing the one of the plurality of wavelength streams into a plurality of time domain demultiplexed wavelength streams (Col.25, lines 31-35);"

The optical time demultiplex patent of Ooi et al. (US Patent 6,118,564) focuses primarily on methods of stabilizing the timing circuitry and identifying each signal channel. The patent gives little or no description of the output data signals, except for where such signals are relevant for the phase detection and bias supply circuitry. For instance with reference to Fig. 7, the light branching element 25 passes one portion of the output optical signal to the optical receiver 26 where it is converted to an electrical signal, whose high frequency components which carry the data are removed by the

electrical bandpass filter 27, allowing only the low frequencies to continue on the phase detection and bias supply circuit 28. The second portion of the output optical signal is passed either to the identification element or to another similar optical time demultiplexing stage.

The fifth embodiment shown in Fig. 12 may lead one to speculate that the output signals c, f, j from optical switches 42-1, 42-2, 42-3 respectively could in fact be used for further optical demultiplexing, but the description (Col. 33 lines 1 to 6) teaches that they are intended for an optical receiver. This in turn implies the termination of the optical stream into a photodetector and consequent conversion into an electrical signal.

It must be realized that *Ooi et al*. actually teach away from further demultiplexing by optical means subsequent to the optical domain demultiplexing they disclose, clearly stating (Col. 23, lines 60 to 63) that the light signal output from optical switch 22 (Fig. 32) via light branching element 25 to identification elements 110 or 111 is identified as a demultiplexed signal. In fact their system would not function if any of the branches of entering the optical domain demultiplexing unit 108 or 109 carried a plurality of wavelengths.

For instance, with reference to their Fig. 7, if the light demultiplexing and branching unit 107A were to pass two or more wavelength channels to optical demux 30-2, the signal stream emanating from the light branching unit 25 to the identification element would also carry two or more wavelength channels. As two or more wavelength channels are superimposed

simultaneously on the same light conductor, a photodetector exposed to such a stream would sum all of the channel signals into a single electrical signal. Under such circumstances, the identification function could not be performed by the identification element.

Another example can be taken from the embodiment in Fig. 12. If the signal stream 'a' input to the optical switch 42-1 were to carry two or more wavelength channels, so would the signal stream 'c' emanating from the same optical switch. Since this would contain more than one signal, the identification function would not be performed correctly, incapacitating the system.

In summary, claims 1 and 15 of the instant application cannot be regarded as an obvious derivation of *Ooi et al.* since *Ooi et al.* teach away from one of the essential elements disclosed in instant application (claim 1(c)).

It is further said in the Office Action that "it would have been obvious to a person having ordinary skill in the art at the time of the invention to incorporate a demultiplexer apparatus, such as the one of *Lin et al.*, to replace the LIGHT DEMULTIPLEXING & BRANCHING in the system of *Ooi et al.* in order to obtain output signal with larger frequency spacing than that of input signals."

While *Lin et al.* (US Patent 6,782,203) teach a scalable optical demultiplexing apparatus with the frequency spacing larger than the predetermined channel spacing (Fig.7), replacement of the LIGHT DEMULTIPLEXING & BRANCHING with a demux unit plus post filters, as suggested, would defeat the

purpose of using the optical time domain demultiplex to reduce the optical bandwidth of the wavelength channels. Such optical bandwidth reduction comprises one of the objects of instant disclosure (for instance, claim 1(b)), for which Lin's patent has no corresponding counterpart.

Claim 2

The Examiner further states that *Lin et al.* (US Pat. 6,782,203) teach a splitting means for splitting the optical signal into at least two sub-signals before launching into the demultiplexing means.

This is a generic means, which is included in many system embodiments, including, for instance, *Ooi et al.* above. Used in isolation, it cannot perform any of the demultiplex functions disclosed in this application, nor in the teachings of *Lin et al.* Hence it complements the optical demultiplexer disclosed in claim 1 of this application.

Claim 3

The Examiner refers to *Ooi et al.* (US Pat. 6,118,564) teaching a clock recovery means (21, Fig. 12) from one of a plurality of wavelength streams. This is a standard means for many time domain multiplex systems to ensure that the demux clock remains synchronised with the incoming signals during changing operating conditions.

There is a material difference between the teachings of *Ooi et al.* and instant application. In Ooi's case, the clock recovery circuit 21 (Fig. 12) can use only a single wavelength optical signal 'a', since multiple wavelength signals in the absence of supplementary wavelength demux will not be identified properly, as explained earlier. In the case of

instant disclosure, the clock recovery signal is derived from a signal comprising a plurality of optical wavelengths.

Claim 4

While it is true, as the Examiner points out, that *Ooi et al*. teach a plurality of time domain demultiplexing means (30-1, 30-2, etc. in their Fig. 7), and Lin et al. teach a plurality of optical filtering means (320, Fig. 7) they cannot be arranged in a sequence corresponding to instant disclosure.

Ooi includes only the elements disclosed in claim 1(a) and 1(b), while Lin has no element corresponding to that disclosed in claim 1(b) of the instant application. While their teachings form a different subsets of the elements contained in instant disclosure, neither of them teach how their systems can be extended their systems to achieve the same result.

Also worthy of note is the fact, that if Lin's post filters (320, Fig. 7) were to be placed in front of Ooi's OTDM (30-1, Fig. 7), they would require a higher figure of merit for the filters than those in instant application (24, Fig. 1)

Claims 5, 6, 7, 8

Lin et al. teachings are quite specifically targeted at a system where the wavelength demultiplex is effected by an array waveguide, which provides a spectral comb of passbands separated by the free spectral range (FSR) of the device. Clearly, the wavelength spacing in this case is an integer multiple of the FSR. However, the instant application discloses the use of non-integer spacings also, which is more general.

However it must be borne in mind that for telecommunications devices to interact in a network, certain standards have been introduced, which specify the channel spacing. The International Telecommunications Union (ITU) frequency grid is one such widely applied standard. Thus, it is convenient and cost-effective that all the demultiplexers disclosed in earlier claims of this application implement these standards.

Claim 9

Lithium Niobate and semiconductor optical amplifier switches are standard components in the telecom field. They will not perform the intended function in isolation, hence their applicability to this invention is claimed within the context of the disclosed WDM - OTDM - WDM demultiplexer structure.

Claim 10

Optical band-pass filters are standard components in the telecom field. As mentioned previously, while Lin et al. disclose them in their patent for use straight after the optical demultilexer (310, Fig. 7), in this invention the specifications required from the filter elements are more relaxed, yielding a cost advantage, because they are located after the OTDM stage.

Claim 11

Return-to-zero (RZ) is one of the more common standard modulation formats in the field, non-return-to-zero (NRZ) being another example. It is convenient for the demultiplexers disclosed in earlier claims to use this format on an optical network.

Claim 12

The Examiner states that Ooi et al. teach that the sum of bit-rates of the plurality of time domain demultiplexed wavelength streams is equal to a bit-rate of one of the plurality of wavelength streams. This teaching was meant to basically reflect the intent to build a system which does not lose incoming data.

Actually this teaching can apply only to the case of the instant application, since Ooi's disclosure does not include a wavelength division multiplex stage following the OTDM.

Claim 16

As explained above in reference to claim 15, in Oo's disclosure clock recovery is performed using a single wavelength signal, whereas in instant application the signal contains more than one wavelength.

Claim 17

As also explained above in reference to claim 15, Lin's patent differs from instant application (claim 1 (b)) in that his system has no provision for reducing the bandwidth of each wavelength channel.

Claims 13 and 14

The Examiner uses Pan et al. (US Patent 5,652,814) as an example of a wavelength splitter on the input end of the demultiplexer as disclosed in Ooi's patent to achieve an equivalent function of instant application. Similar to Lin's 's patent, Pan differs from instant application (claim 1 (b)) in that his system has no provision for reducing the bandwidth of each wavelength channel by, for instance, OTDM. Even if a

splitter were incorporated according to Pan's patent, it would result in a lower performance system in terms of bit-rate limitations.

Furthermore, Pan's configuration introduces additional optical loss due to the multiple demux stages required. The larger number of components tends to increase manufacturing costs. Above all, the demands on the filter figure-of-merit are much greater, resulting in additional manufacturing costs.

As an object of the instant application is a low loss, high bit-rate demux, Pan's patent appears to be teaching away from this objective.

Regarding claim 14, Ooi's teaching on clock recovery, even if derived from M sub-signals, still operates at a single wavelength in contrast to instant disclosure.

In summary, it is believed that amended claim 1 and all claims dependent thereon are patentable in view of cited references.

In view of the foregoing amendments and remarks, it is respectfully submitted that that amended claim 1 and all claims dependent thereon are patentable in view of cited references.

Early and favorable reconsideration of the Examiner's objections would be appreciated.

Should any minor informalities need to be addressed, the Examiner is encouraged to contact the undersigned attorney at the telephone number listed below.

Please charge any shortage in fees due in connection with the filing of this paper, including Extension of Time fees, to Deposit Account No. 50-1465 and please credit any excess fees to such deposit account.

Respectfully submitted,

Dated: August 3, 2005

MATTHEW A. PEQUIGNOT
Reg. No. 43,851
Attorney for Applicant

Hall, Myers, Vande Sande & Pequignot
10220 River Road, Ste. 200
Potomac, Maryland 20854
Telephone: (301) 983-2500

MS/ara